Claims

Sub B A1

1. A method for modeling an object composed of one or more components, comprising:

inputting data for each component of the object, the data including Cartesian coordinates expressed in Euclidean space of a plurality of points **x** of each component;

encoding each point **x** as a vector x in a general homogeneous space by $x = (\mathbf{x} + \frac{1}{2}\mathbf{x}^2 e + e_*)E = \mathbf{x}E - \frac{1}{2}\mathbf{x}^2 e + e_*$, where e and e_* are basis null vectors of a Minkowski space E; and

associating a plurality of general homogeneous operators with each data construct to generate a model of the object.

2. The method of claim 1 further comprising:

supplying run-time parameters for the plurality of operators; and

applying the plurality of general homogeneous operators to each encoded point **x** of each associated component to manipulate the model of the object.

Sub A2

3. The method of claim 1 further comprising:

measuring a scalar $\mathbf{d}_{ab}$ between two component points **a** and **b** encoded as general homogeneous points a and b by $\mathbf{d}_{ab}{}^2 = (a - b)^2 = -2a \bullet b$.

4. The method of claim 1 wherein a line through component points **a** and **b** encoded as general homogeneous points a and b is modeled by $e \wedge a \wedge b$, and a length $\mathbf{l}_{ab}$ of a line segment connecting component points **a** and **b** is $(\mathbf{l}_{ab})^2 = (e \wedge a \wedge b)^2 = (a - b)^2$.

5. The method of claim 1 wherein a plane through component points **a, b,** and **c** encoded as general homogeneous points a, b, and c is modeled by $e \wedge a \wedge b \wedge c$, and an area $A_{\mathbf{abc}}$ defined by component points **a**, **b**, and **c** is $(A_{\mathbf{abc}})^2 = \frac{1}{4}(e \wedge a \wedge b \wedge c)^2$.

6. The method of claim 1 wherein a sphere **s** with radius **r** centered at a component point **c** encoded as a general homogenous radius r and center c is generated by a vector $\mathbf{s} = c + \frac{1}{2}r^2 e$.

7. The method of claim 1 wherein a sphere **s** determined by four component points **a, b, c, d** encoded as general homogeneous points a,b,c,d is generated by $\mathbf{s} = IE\,(a \wedge b \wedge c \wedge d)$, where I is a largest k-blade.

8. The method of claim 7 wherein one of the general homogeneous points a,b,c,d is equal to the point e so that **s** defines a plane through the point e.

9. The method of claim 5 wherein a distances between a component point **a** and a component plane **p** is an inner products $a \bullet p$ of an encoded point a and an encoded plane p.

10. The method of claim 6 wherein a distances between a component point **a** and a component sphere **s** is an inner product $a \cdot s$ of and encoded point a and the encoded sphere p.

11. The method of claim 6 wherein a distance between two component spheres $\mathbf{s}_1$ and $\mathbf{s}_2$ encoded as spheres $s_1 = c_1 + \frac{1}{2} r_1^2 e$ and $s_2 = c_2 + \frac{1}{2} r_2^2 e$ is generated by $s_1 \cdot s_2 = c_1 \cdot c_2 + \frac{1}{2}(r_1^2 + r_2^2) = -\frac{1}{2}[(c_1 - c_2)^2 - (r_1^2 + r_2^2)]$.

12. The method of claim 1 wherein the object is a rigid body, and a motion of the rigid body is determined by a time dependent displacement versor $D=D(t)$ satisfying a differential equation $\dot{D} = \frac{1}{2} VD$, with "screw velocity" V given by $V = -I\omega + e\mathbf{v}$, where ω is a velocity and $\mathbf{v}$ is a translational velocity of the rigid body.

13. The method of claim 12 wherein *dynamics* of the rigid body are determined by a differential equation $\dot{P} = W$, where $P = -I\mathbf{L} + e_*\mathbf{p}$, and $W = -I\mathbf{T} + e_*\mathbf{F}$, where $\mathbf{L}$ is an angular momentum and $\mathbf{p}$ is a translational momentum of the rigid body, while $\mathbf{T}$ is the a torque and $\mathbf{F}$ is a net force on the rigid body.

14. The methods of claim 12 wherein the rigid body includes n linked rigid components, and a motion of the rigid body is modeled by n time dependent displacement versors $D_1, D_2, \ldots, D_n$, and a motion of a k^{th} linked rigid component is determined by a versor product $D_1 D_2 \ldots D_k$.

15. The method of claim 1 wherein the objects is a robot composed of a plurality of links connected at joints.